Chapter 3 REVIEW

Knowledge and Understanding

Select the letter of the best answer below.

1. Which of the following best describes Rutherford's atomic model?
- **a.** indivisible (nothing smaller than the atom exists)
- **b.** has a very small nuclear core
- **c.** contains protons
- **d.** uses quantum physics to explain electron properties
- **e.** All of these are correct.

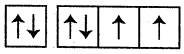
2. Which observation in the cathode ray tube experiments did not contribute to the conclusion that the electron is found in atoms of all matter?
- **a.** The beam travelled in straight lines.
- **b.** Changing the gases inside the cathode ray tube did not alter the path of the beam.
- **c.** Changing the metals of the electrodes did not change the path of the beam.
- **d.** Two of these are correct.
- **e.** All of these are correct.

3. The history of science records the discoveries and achievements of various scientists whose models of the atom helped to develop and further our understanding of the nature and behaviour of matter. Choose the correct historical sequence of atomic models from the following choices.
- **a.** Dalton, Rutherford, Thomson, Bohr
- **b.** Thomson, Rutherford, Bohr, Dalton
- **c.** Dalton, Thomson, Rutherford, Bohr
- **d.** Dalton, Bohr, Rutherford, quantum
- **e.** Dalton, Bohr, Thomson, quantum

4. The emission spectrum of an element
- **a.** has a dark background with bright-coloured lines.
- **b.** has a rainbow-coloured background with dark lines.
- **c.** has lines that represent the location of electrons inside the atom.
- **d.** has spaces between the lines that represent the distance between electrons inside the atom.
- **e.** is a continuous spectrum of visible light.

5. Which one of the following electron configurations represents an electron in an excited state?
- **a.** $[Ar]4s^2 3d^{10} 4p^3$
- **b.** $[Ar]4s^2 3d^{10} 4p^6$
- **c.** $[Ar]4s^2 3d^{10} 4p^2$
- **d.** $[Ar]4s^2 3d^{10} 4p^4$
- **e.** $[Ar]4s^2 3d^{10} 4p^3 5s^1$

6. Which of the following elements could have the following valence orbital diagram?



- **a.** carbon
- **b.** nitrogen
- **c.** boron
- **d.** sulfur
- **e.** neon

7. First ionization energy is
- **a.** the amount of energy an electron must gain to escape from a neutral atom.
- **b.** the amount of energy an electron must lose to escape from a neutral atom.
- **c.** the amount of energy an atom gains when it first becomes an ion.
- **d.** Two of these are correct.
- **e.** All of these are correct.

8. Electron affinity refers to
- **a.** the energy change accompanying the addition of 1 mol of gaseous atoms or ions.
- **b.** the attraction of the nucleus for electrons.
- **c.** the attraction of electrons for one another.
- **d.** the energy change of electrons of noble gas elements.
- **e.** none of the above.

9. In which period can you start to use condensed electron configurations?
- **a.** 1
- **b.** 2
- **c.** 3
- **d.** 4
- **e.** 5

10. Atomic radius decreases
- **a.** when the effective nuclear charge decreases.
- **b.** when the inner core decreases.
- **c.** down a group.
- **d.** across a period.
- **e.** in all of the above situations.

11. Which property changes in the same way that the atomic radius does in the periodic table?
- **a.** electron affinity
- **b.** atomic number
- **c.** ionization energy
- **d.** They all change in the same way.
- **e.** None of them change in the same way.

12. Which two sets of quantum numbers describe electrons in the same sublevel?

a. i, ii

b. iii, v

c. ii, iii

d. iv, v

e. ii, iv

	n	l	m_l	m_s
i.	2	1	0	$-\frac{1}{2}$
ii.	2	1	−1	$+\frac{1}{2}$
iii.	3	1	−1	$+\frac{1}{2}$
iv.	2	2	−1	$+\frac{1}{2}$
v.	3	2	−1	$+\frac{1}{2}$

13. When comparing the properties of carbon atoms and oxygen atoms, which statement is correct?

a. Carbon and oxygen have the same spin quantum number, m_s.

b. Carbon and oxygen have the same magnetic quantum number, m_l.

c. Carbon and oxygen have the same principal quantum number, n.

d. Carbon has a greater orbital-shape quantum number, l, than oxygen.

e. Oxygen has a greater orbital-shape quantum number, l, than carbon.

14. Helium behaves like a noble gas because

a. its valence shell is completely filled.

b. its outermost orbital is completely filled.

c. its outermost energy level is completely filled.

d. Two of these are correct.

e. All of these are correct.

Answer the questions below.

15. In what ways were Dalton's and Thomson's atomic models similar? In what ways were they different?

16. In what ways were Thomson's and Rutherford's models of the atom similar? In what ways were they different?

17. What is common to all atomic models, from Dalton's to Bohr's?

18. What property is common to all electromagnetic radiation?

19. Describe how the motion of an electron in Bohr's model of the atom is different from the motion of an electron in the quantum mechanical model of the atom.

20. Bohr's atomic model provides specific information about the energy and location of electrons in an atom. That is, the model predicts that both of these can be known with certainty. What structures (such as the nucleus) in the Bohr model are necessary to allow for these concepts?

21. Explain how periodic trends in ionization energy and electron affinity explain why atoms of elements in Group 1 and Group 2 tend to bond with other elements by forming positive ions in ionic compounds.

22. A nitrogen atom has a total of three electrons in its $2p$ orbitals. Are any of these electrons paired? Explain how you know.

23. The quantum mechanical model provides information about the atom that is certain and uncertain. Which information is certain? Which is uncertain?

24. What information do the quantum numbers provide about an orbital?

25. What two things does the principal quantum number, n, describe about an orbital and the electron in it?

26. Why does it make sense that an electron can be found farther away from the nucleus in an orbital of a higher energy level than in the same type of orbital in a lower energy level?

27. What is the Pauli exclusion principle, and how is it related to the spin quantum number, m_s?

28. What is Hund's rule and its significance?

29. Why does it make sense that electron configurations represent atoms in their ground state and not their many excited states?

30. What are the general trends for atomic radius down a group and across a period in the periodic table? Account for these trends.

Thinking and Investigation

31. If it had turned out that the cathode beam particle had a neutral charge, which experimental finding(s) would have remained the same in all of the cathode ray tube experiments?

32. Without consulting a periodic table, determine to which period, group, and block the element with the electron configuration $[Xe]6s^25d^{10}$ would belong.

33. Write the complete electron configuration for the element in Period 5 and Group 15.

34. List the 3*s*, 5*s*, 2*p*, 4*p*, 3*d*, and 5*d* orbitals in order, from the lowest energy to the highest energy.

35. List all possible values of m_l for electrons in the element having the electron configuration [Ar]$4s^2 3d^5$.

36. Use a basic periodic table, which does not contain electron configurations, to determine which element is defined by[Ar]$4s^2 3d^8$.

37. Use a basic periodic table, which does not contain electron configurations, to determine which element is defined by [Ne]$2s^2 2p^1$.

38. Use a basic periodic table, which does not contain electron configurations, to determine which element is defined by [Kr]$5s^2 4d^{10} 5p^4$.

39. If the last electron to be added to an atom was the seventh electron in the third energy level, what element would that be?

40. If the last electron to be added to an atom was the 44th electron in the atom, what element would that be?

41. If the last electron to be added to an atom was the sixth electron in the second energy level, what element would that be?

42. If the last electron to be added to an atom was the second electron in the sixth energy level, what element would that be?

43. Some chemists do not include the *d* electrons in the condensed electron configurations for large *p*-block elements. For example, they would write the condensed electron configuration for tin as [Kr]$5s^2 2p^2$. Why do you think this might be a valid way of writing the electron configurations?

44. Use Z_{eff} to predict which atom should be larger between boron and fluorine.

45. Use Z_{eff} to predict which atom should be larger between magnesium and silicon.

46. Use Z_{eff} to predict which atom should be larger between calcium and selenium.

47. The largest artificial element that scientists have been able to create to date has an atomic number of 118 and occupies the last available spot on the modern periodic table. Using only the organization of the periodic table, determine each of the following for element 118:

a. condensed electron configuration
b. set of quantum numbers for the last electron to be added to it
c. physical state at room temperature
d. reactivity

48. T/I Referring only to a periodic table, arrange the following sets of elements in order of increasing first ionization energy. Briefly explain your reasoning.

a. Na, Si, Ar
b. Mg, Ca, Ba
c. He, Li, Be

49. T/I Consider the electron configuration: $1s^2 2s^2 2p^4$.

a. Assume the electron configuration represents a neutral atom in its ground state. What element does it represent? Explain how you know.
b. What information does this electron configuration notation provide?
c. What information does this electron configuration notation *not* provide?

Communication

50. BIG IDEAS Technological devices that are based on the principles of atomic and molecular structures can have societal benefits and costs. Ultraviolet (UV) radiation technology is used in a wide variety of applications, including disinfection, curing of polymers and resins, detection of trace chemicals, and non-invasive testing. Research one of these and create a graphic organizer that lists the benefits, costs, and potential hazards to society.

51. BIG IDEAS Technological devices that are based on the principles of atomic and molecular structures can have societal benefits and costs. X rays were discovered "accidentally" when closed photographic plates were exposed near cathode ray tubes that were left operating. Cathode ray tubes are used in CRT computer monitors. Research the discovery of the X ray, and in a series of small paragraphs, describe how X rays can be released in cathode ray tubes, the precautions that are taken to prevent the unguarded release of X-ray radiation from the CRT computer monitor, and any other precautions or warnings that are necessary that extend from the use of a cathode ray tube in a computer monitor.

52. Use labelled diagrams to compare the concept of an orbit with the concept of an orbital. Be as detailed as possible in your answer.

53. The concept of orbitals overlapping in three-dimensional space to create an overall spherical atom is a difficult image for many people to construct in their minds. Suggest or build a model that can help to give this image more concrete substance to help people understand it better.